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SPECIFICATION FOR THE INSTALLATION OF ELECTRICAL RESISTANCE STR--ETC(U)
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AERONAUTICAL RESEARCH LABORATORIES

MELBOURNE, VICTORIA

Structures Technical Memorandum 301

SPECIFICATION FOR THE INSTALLATION OF ELECTRICAL
RESISTANCE STRAIN GAUGES ON STRAIN
PAIRS COUNTER AIRCRAFT.

S.W. GEE

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SUMMARY

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This document lays down the requirements and procedures, for the installation and checking of strain gauges and associated wiring, on service aircraft, for use with strain pairs counters.

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FIGURES

DOCUMENT CONTROL DATA

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1. INTRODUCTION

A number of RAAF aircraft are to be strain gauged, as part of a program designed to monitor the in-flight fatigue damage, accumulated by service aircraft during normal squadron usage.

Flight strains are to be measured by gauges, strategically placed on the structure and monitored by strain pairs counters.

The materials and methods of application recommended in this memo, have been successfully used for flight trials over several years and have proved very reliable. Any deviations from the suggested methods should be thoroughly checked before use on the aircraft.

2. SELECTION OF STRAIN GAUGE LOCATIONS

Only highly trained ARL personnel should select, or approve the locations of strain gauge positions.

The chosen locations must be easily accessible to permit the best strain gauge practices to be employed, thus ensuring adequate reliability for the installation.

The known position at which fatigue failure may occur in the structure may not be accessible for gauging, so any location selected must bear a known and reliable strain relationship with this critical position, otherwise data from the gauges will not be meaningful in terms of fatigue life of the structure.

Locations should be on thermally stable components such as wing main spar booms, remote from engine or aerodynamic heating and clear of noisy electrical equipment such as generators, electric motors, radio and radar transmitters. Cabling should also be routed clear of these areas whenever it is possible to do so.

3. RADIO FREQUENCY INTERFERENCE

The effect of R.F. pick up on strain gauge installations, amplifiers and recording equipment is relatively unknown, so some research should be conducted to check the effect of intermittent radio and radar transmissions. The installation on each type of aircraft should be checked to ensure that extraneous signals from these sources are not recorded on the strain gauge instrumentation.

4. STRAIN GAUGE BRIDGE CONFIGURATION

The requirement for maximum bridge output and minimum thermal errors dictates that four strain gauges from the same lot number, be fitted at each location and wired as a full four arm bridge. Fig. 1.

A Poissons ratio bridge should be used wherever possible for direct strain measurement as shown in Fig. 2.

If this is not practicable, two of the gauges may be attached to a unstrained dummy plate, mounted close to the active gauges and thermally connected to the structure, to provide correct temperature compensation as shown in Fig. 3.

The full bending bridge shown in Fig. 4 should be used if the bending strain on a cross section of a spar is required. It is unlikely that this configuration will be used on strain pairs counter aircraft, where local strain is normally required rather than general bending strain on a section.

5. MATERIALS

5.1 Strain Gauges

Micro-Measurements type WK-13-250BG-350 strain gauges with a resistance of 350 Ohms and a gauge factor of 2.00 are recommended. Gauges of equal transducer quality by a different manufacturer would be acceptable.

5.2 Adhesive

Micro-Measurements M Bond 200 cyanoacrylate strain gauge adhesive is recommended. An equivalent high quality strain gauge adhesive would be acceptable.

5.3 Protective Coatings

Micro-Measurements M Coat F strain gauge coating is recommended. A brush on strain gauge coating followed by a coating of P.R.C. rubber sealant type PR1422B2 would be an acceptable alternative.

5.4 Strain Gauge Terminals

Micro-Measurements type CEG-75c Strain gauge terminals or equivalent are recommended.

5.5 Wiring

Internal bridge wiring should be carried out using P.V.C. covered multi strand hook up wire. In areas where fuel, hydraulic oil or high temperatures may be present, P.T.F.E. insulated wire should be used. The wire should be equivalent to 5 strands, 0.0193 millimetres diameter or larger.

Each gauge bridge should be connected to the instrumentation package by two, shielded, twisted pair cables, one pair for the bridge input and one pair for the bridge output. Raychem type A2620-500 ZAS-WTB 1936A-STB cable or equivalent is recommended. Smaller wire sizes should be avoided and cable runs kept as short as possible to avoid thermal and calibration errors caused by the higher resistance of finer wires. The use of plugs should be avoided where possible.

5.6 Miscellaneous

Solder-resin cored, 22 gauge, 60/40 "Ersin", or equivalent.

Flux Remover - "Micro-Measurements" strain gauge resin solvent or equivalent.

Heat sink compound - "Dow Corning" type 340 or equivalent.

Tape, transparent - "Scotch", cat 136, 12 mm x 33 m. There is no known alternative to this tape for this application.

Tape, masking.

5.7 Surface Preparation Materials

Micro-Measurements M-Prep Conditioner A and M-Prep Neutraliser 5 or equivalent.

Aluminium oxide paper - 320 grit.

Clorothene NU or Fereon.

Acetone.

Methyl Ethyl Ketone.

6. TOOLS

Soldering iron - small, temperature controlled, "Adcola" E.C.T. series or equivalent.

Diagonal cutter - small.

Pliers - small, long nose, fine point.

Tweezers - small, straight fine point and angled fine point.

Steel rules - flexible 30 CM and 15 CM.

Set square - small.

Magnifying glass - small.

7. INSTRUMENTS

Strain gauge installation tester - "Vishay Instruments", model 1300 or "Peekel" model WE 678, low voltage gauge resistance meter or equivalent.

Static strain measuring meter - "Vishay Instruments", model P-350 digital strain indicator or "Peekel" model B105 or an equivalent quality instrument.

8. INSTALLATION CONTROL

Trained strain gauge personnel must be employed to install the strain gauges. These personnel should be checked at six monthly intervals to ensure that the necessary quality of workmanship is being maintained. ARL staff will train and check R.A.A.F. personnel for the task.

9. INSTALLATION PROCEDURES

9.1 Surface Preparation

Surface preparation shall be in accordance with procedures laid down in Micro-Measurements Instruction Bulletin B-129, "Surface Preparation for Strain Gauge Bonding", or to a equivalent standard approved by ARL personnel.

Removal of protective anodising or plating, from the surfaces to be strain gauged, must be approved by ARL staff from Materials Division, to ensure that stress corrosion is not initiated at these locations.

Correct coating of the prepared areas after strain gauging normally eliminates this hazard, but some materials are particularly sensitive to contamination and their protective coatings must be preserved intact.

9.2 Strain Gauge Attachment

Strain gauge attachment shall be in accordance with procedures laid down in Micro-Measurements Instruction Bulletin B-127, "Strain Gauge Installations with M Bond 200 Adhesive", or to an equivalent high standard approved by ARL strain gauge personnel.

9.3 Protective Coatings

Protective coatings shall be applied strictly in accordance with the manufacturers instructions or to an equivalent high standard approved by ARL strain gauge personnel.

9.4 Wiring and Soldering

Wiring and Soldering shall be carried out to a high instrumentation standard as approved by ARL strain gauge personnel.

Micro-Measurements Tech Tips TT-127, "The Proper Use of Bondable Terminals in Strain Gauge Applications", details the correct procedure for wiring both the strain gauge leads and the instrumentation leads to the gauge terminals. These instructions should be closely followed.

10. GAUGE INSTALLATION CHECK OUT

The strain gauges must be checked after their attachment and wiring to their terminals, after connection to the instrumentation cables and after final protective coatings are applied.

10.1 Resistance Measurements

Each attached strain gauge must be checked for correct terminal resistance and correct resistance to earth, with the gauge installation tester.

For the recommended gauges, resistance should be 350 ± 1.05 Ohms and resistance to earth greater than 10,000 MegOhms. The minimum acceptable resistance to earth for each complete gauge bridge is 100 MegOhms.

10.2 Gauge and Circuit Integrity

Proper installation of the gauges must be checked with the static strain measuring meter as follows. Each complete gauge bridge is connected to the meter as per the meter maker's instructions and the zero reading checked. Bridge balance should be within ± 1500 micro-strain of the strain meter's true zero balance reading and remain steady with no drift.

To test that the gauges are properly attached, the strain meter is adjusted to the null balance condition. A piece of teflon or plastic sheet should be placed over a gauge and a piece of 3 millimetre thick rubber pad placed on top. Pressing on the rubber pad with a finger should result in a deflection of the strain meter. On removal of the pressure the strain meter should return to zero. Each gauge should be checked in this manner. This method may also be used to check that gauge bridges are connected to their correct channels on the flight instrumentation, by pressing each gauge bridge in turn and ensuring that only the correct recorder channel responds.

All the relevant resistances and strain meter readings measured in the above tests should be recorded for future reference, together with details of the gauge type, resistance, strain factor, batch number and location of the gauge bridge on the aircraft. Photographs of the gauge locations should also be taken before final proofing, and carefully labelled for future use.

11. FAULT FINDING

If the null balance of the strain gauge bridge is outside the meter range, check that the circuit connections, the solder joints and the individual strain gauges are correct, and rectify any errors.

Should the meter reading be unstable, the solder joints should be examined and the strain gauges checked to ensure there are no air bubbles under the gauge grid.

If bubbles are present under the gauge, or the meter reading does not return to zero after pressing on the gauge, the gauge must be replaced.

12. INSPECTION OF MATERIALS

Both adhesives and protective coatings should be checked for satisfactory curing before their initial usage and at the end of the manufacturers recommended storage life. If the materials are still satisfactory at this time, they may be used for a further 30 days after testing.

If the adhesive thickens during storage or the coating fails to cure in the stated time, it must be discarded.

Storing the adhesive in a refrigerator greatly extends its useful life, but it must be properly sealed before refrigeration and allowed to return to room temperature before opening to avoid contamination by moisture condensing from humid air on the cold surface.

13. VERIFICATION OF THE COMPLETE INSTALLATION

After the strain gauge installation has been completed and connected to the strain pairs counter instrumentation, a final check of all gauge positions should be carried out.

Known loads should be applied to the aircraft structure and the response of the strain gauges checked on the recorder. Information on the loading points, the magnitudes of the applied loads and the expected outputs of the gauge positions will be given by ARL personnel for the particular type of aircraft being tested.

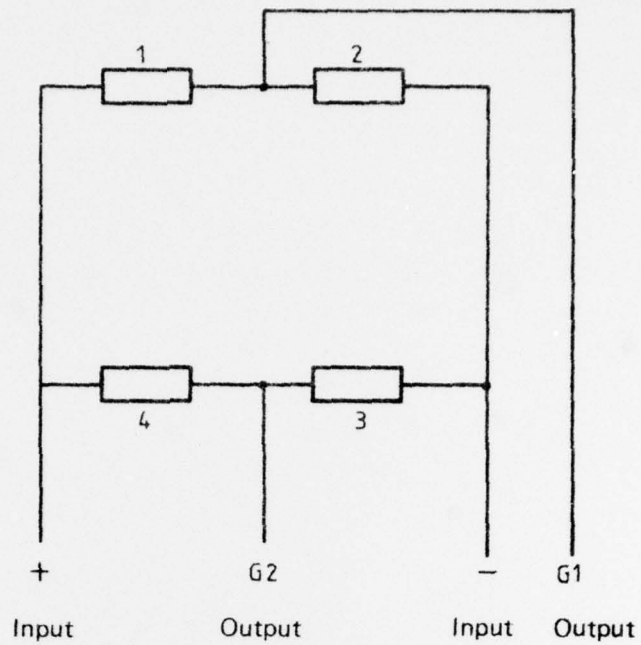


FIG. 1. STRAIN GAUGE BRIDGE CIRCUIT

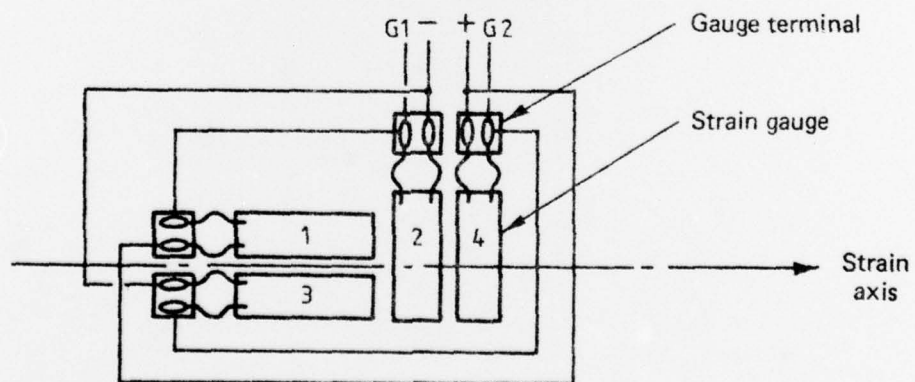


FIG. 2. POISSONS RATIO STRAIN GAUGE BRIDGE

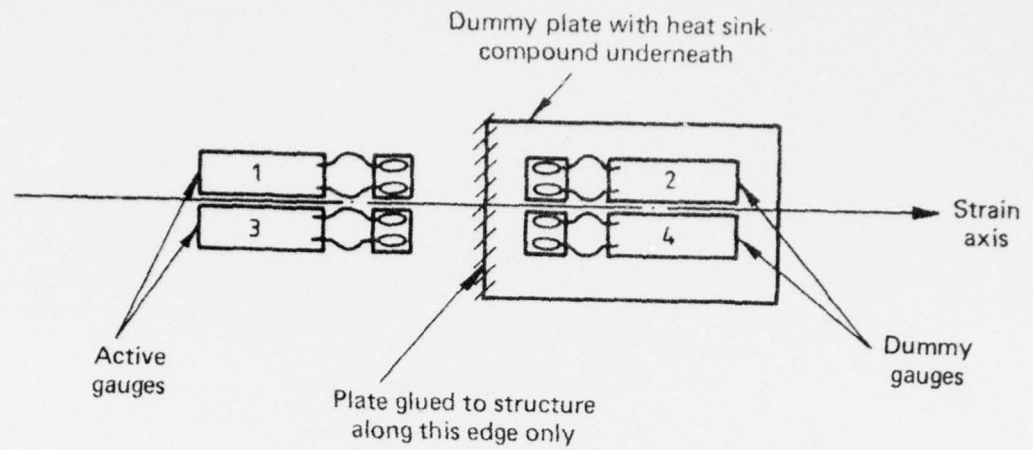


FIG. 3. STRAIN GAUGE BRIDGE WITH DUMMY GAUGES.
(WIRING OMITTED FOR CLARITY)

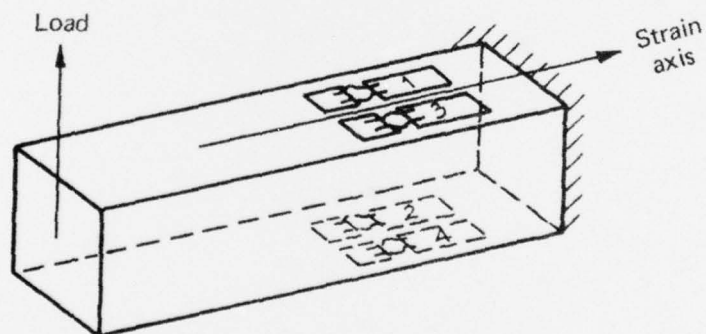


FIG. 4. FOUR ARM BENDING BRIDGE
(WIRING OMITTED FOR CLARITY)

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16. ABSTRACT:

This document lays down the requirements and procedures, for the installation and checking of strain gauges and associated wiring, on service aircraft, for use with strain pairs counters.



